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## Appendix C: Post-Processor for Air Quality

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### Overview of Technique

To estimate the effects of a TCM alternative on the region's emissions, travel changes were estimated with the DVRPC transportation model, the TDM evaluation model, or supplemental specialized techniques. These methods produced either estimates of traffic volume changes on the highway network, or changes in vehicle miles of travel (VMT) on groups of roadways in specific counties. The Post Processor for Air Quality (PPAQ) and MOBILE5a were then used to calculate the levels of emissions for the region which would result; estimates for alternatives were compared with the base case to produce the net benefit of the alternative.

MOBILE5a is USEPA's program which calculates emissions factors. It has several groups of input variables which describe the vehicle fleet and operating conditions:

- Traffic flow data, such as speeds, cold start fractions, and vehicle types;
- Vehicle fleet data, such as age distributions and inspection/maintenance status;
- Fuel parameters, such as reformulated or oxygenated fuels and refueling controls; and
- Environmental variables, including temperature.

For most of the TCMs which were considered, the vehicle fleet, fuel, and environmental data were held constant. They were specified to reflect 1996 conditions, including Pennsylvania's most current (at the time of analysis) proposals for enhanced inspection/maintenance and fuels. In some cases adjustments to the fleet descriptions or fuel parameters were made to reflect specific conditions of the TCM alternative.

### Calculation of Traffic Flow Variables Using PPAQ

For most alternatives, the TCM produced changes in the amount and character of travel. The effects were reduced to changes in VMT, speeds, or the number of cold starting vehicles, using the PPAQ software. PPAQ performs a number of operations which together compile the traffic flow variables needed for emissions analysis. These operations include the following:

**Hourly Distribution and Vehicle Type Mix** - Each link of the DVRPC model's highway network contains a 24-hour traffic volume. Pattern data provided by PennDOT are used to disaggregate each link's volume to 24 hourly volumes, and to further split those volumes to the eight vehicle types used by MOBILE. These hourly data are then used for calculating speeds, as described below.

**VMT Accumulation** - VMT data is accumulated from the alternative's network by multiplying individual link distances by the traffic volume on the link. For each alternative, VMT is separately accumulated for four time periods (morning and evening peak periods, midday, and night) and for each facility type and county. Factors were derived from the 1990 condition to adjust the VMT to

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reconcile with totals reported to the Highway Performance Monitoring System (HPMS). For freeways and arterials the adjustments are small, since virtually all of those facilities are in both the model and HPMS. Local streets are under-represented in the model, so larger adjustments are needed to account for this lack of coverage. Additional adjustments were also derived from PennDOT data to convert from the typical annual weekday represented by the model, to a July weekday.

These factors were then applied to each TCM alternative's VMT to produce the total amount of travel, as derived from the model network. For some TCMs the VMT change was estimated directly without reassignment of traffic to the network. In those cases, the accumulated VMT totals were adjusted by the calculated change due to the TCM.

**Cold / Hot Start Fractions** - As a starting point in the base conditions, EPA's recommended default cold and hot-start fractions (20.6 and 27.3 percent respectively) were applied to all VMT. Some TCMs involve actions which will change the number of vehicular cold starts. For those TCMs, the amount of cold-start VMT which changed to hot stabilized, or which was eliminated, was estimated. This differential VMT was input to PPAQ, which calculated modified cold start percentages for each county, facility type, and time period. The new fractions were then input to MOBILE as the TCM's emissions factors were calculated.

**Speed Estimation** - Physical attributes of each highway segment are contained in the model's network database, and include facility type, area type, and number of lanes. Using this information the zero-volume speed and capacity of the segment are estimated. Truck percentage adjustments are then applied to produce an adjusted hourly capacity.

For facility types which do not have control devices (i.e. freeways and expressways), a modified BPR formula with adjusted coefficients is used to calculate the speeds that will occur on each segment. For other facility types (i.e. arterials and local streets) an intersection approach model is used to simulate the effect of traffic signals on speed. For each type of facility (differentiated by type, number lanes, and area type), key parameters such as average signal spacing, cycle length, green time, additional approach lanes, and progression factors are extracted from a lookup table. Using delay equations from the 1985 Highway Capacity Manual, the effect of traffic volume on traffic signal delay is calculated and added to the link travel time calculated for unsignalized segments. Field travel time inventories were performed on freeways within Philadelphia to support calibration and validation of the speed algorithms.

The result of this process is, for each highway segment, an estimated average travel time and speed for each hour of the day. The average time is multiplied by volume to produce vehicle hours of travel (VHT). VHT is then accumulated for each of four time periods, county, and facility type, consistent with the way VMT is accumulated. Average speed is then calculated by dividing VMT by VHT for each combination.

**Emissions Calculation** - The procedures described above assemble for each cell an average speed, cold start percentage, and vehicle type mix, which comprise the traffic flow variables input to

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**MOBILE.** It is then used to calculate an emission factor (in grams per vehicle mile) for each of the three criteria pollutants — VOC's, CO, and NO<sub>x</sub>. This calculation is done for each combination of county, facility type, and time period. The diurnal and evaporative VOC emission factors calculated by MOBILE are adjusted to account for the time of day modeling. Finally, the emission factors for each cell are multiplied by their respective VMT, and summed to produce the region emission estimate for the TCM alternative.

### **Model Outputs**

For each run of the PPAQ/MOBILE system, a number of outputs are generated:

- VMT for each cell, or combination of county, facility type, and time period; subtotals for each county and facility type; and totals for the region;
- Average Speed for each cell, plus averages for each county and facility type and for the region; and
- Emission quantities of VOC's, CO, and NO<sub>x</sub> for each cell, plus subtotals and region totals.







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**Appendix D: List of Reports Used for Background Information**

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- Chicago Area Transportation Study. "Sample CMAQ Calculations #7: Analysis Summaries for: Rail Station Parking Lots, Bike Lockers, Bike Paths," Compiled by the Bicycle Coalition of the Delaware Valley.
- Delaware Valley Regional Planning Commission. Direction 2020 Report Number 5: Journey-to-Work Trends in the Delaware Valley Region, 1970 - 1990. June, 1993.
- Delaware Valley Regional Planning Commission. Direction 2020 Report Number 11: Overview of Transportation Control Measures. August, 1993.
- Delaware Valley Regional Planning Commission. I-95 Intermodal Mobility Project: Heading for the Twenty-First Century. Report #11, Rail Passenger Survey. Prepared for the Pennsylvania Department of Transportation, January, 1991.
- Delaware Valley Regional Planning Commission. Regional Analysis of Parking. August, 1993.
- Delaware Valley Regional Planning Commission. Regional Park and Ride Assessment: Highway Related Facilities. January, 1993.
- Delaware Valley Regional Planning Commission in Association with R.L. Banks and Associates, Inc., Main Line Management Services, Inc., LTK Engineering Services, and Canby Associates. Philadelphia - Harrisburg Rail Study. Prepared for the Pennsylvania Department of Transportation, January, 1992.
- JHK and Associates in Association with Gannett Fleming, Inc. and Michael Baker, Jr. Inc. Traffic and Incident Management System for the Philadelphia Area. Submitted to the Pennsylvania Department of Transportation, District 6, the Pennsylvania Turnpike Commission, and the Federal Highway Administration, September 11, 1992.
- Kessler, Jon and William Schroeder. "Meeting Mobility and Air Quality Goals: Strategies that Work," United States Environmental Protection Agency, Office of Policy Analysis, Draft Report, April 20, 1993.
- METRA and the Chicago Area Transportation Study. "Sample CMAQ Calculations #1: Commuter Station Auto and Bicycle Parking," Compiled by the Bicycle Coalition of the Delaware Valley.
- Orth - Rodgers and Associates, Inc. City of Philadelphia Center City Signal Improvement Project - Feasibility Study. Submitted to the Pennsylvania Department of Transportation, January, 1991.
- Pennsylvania Department of Transportation, Bureau of Public Transportation. Pennsylvania Mass Transit Statistical Report: 1991-92. 1993.
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Pennsylvania Department of Transportation, Bureau of Public Transportation. Pennsylvania Mass Transit Statistical Report: 1987-88. 1989.

Pickrell, Don H. "Federal Tax Policy and Employer-Subsidized Parking," John A. Volpe National Transportation Center, Research and Special Programs Administration, United States Department of Transportation. Prepared for Commuter Parking Symposium, Municipality of Metropolitan Seattle, December 6-7, 1990.

Southeastern Pennsylvania Transportation Authority. A New Look at Restoration of Rail Service to Newtown. January, 1991.

United States Department of Commerce, Economics and Statistics Administration, Bureau of the Census. County Business Patterns - New Jersey, 1990. 1992.

United States Department of Commerce, Economics and Statistics Administration, Bureau of the Census. County Business Patterns - Pennsylvania, 1990. 1992.

United States Department of Commerce, Economics and Statistics Administration, Bureau of the Census. Statistical Abstract of the United States - 1990.

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